

MULTIPLE JUNCTION CELL CHARACTERIZATION USING THE LBIC METHOD: EARLY RESULTS, ISSUES, AND PATHWAYS TO IMPROVEMENT

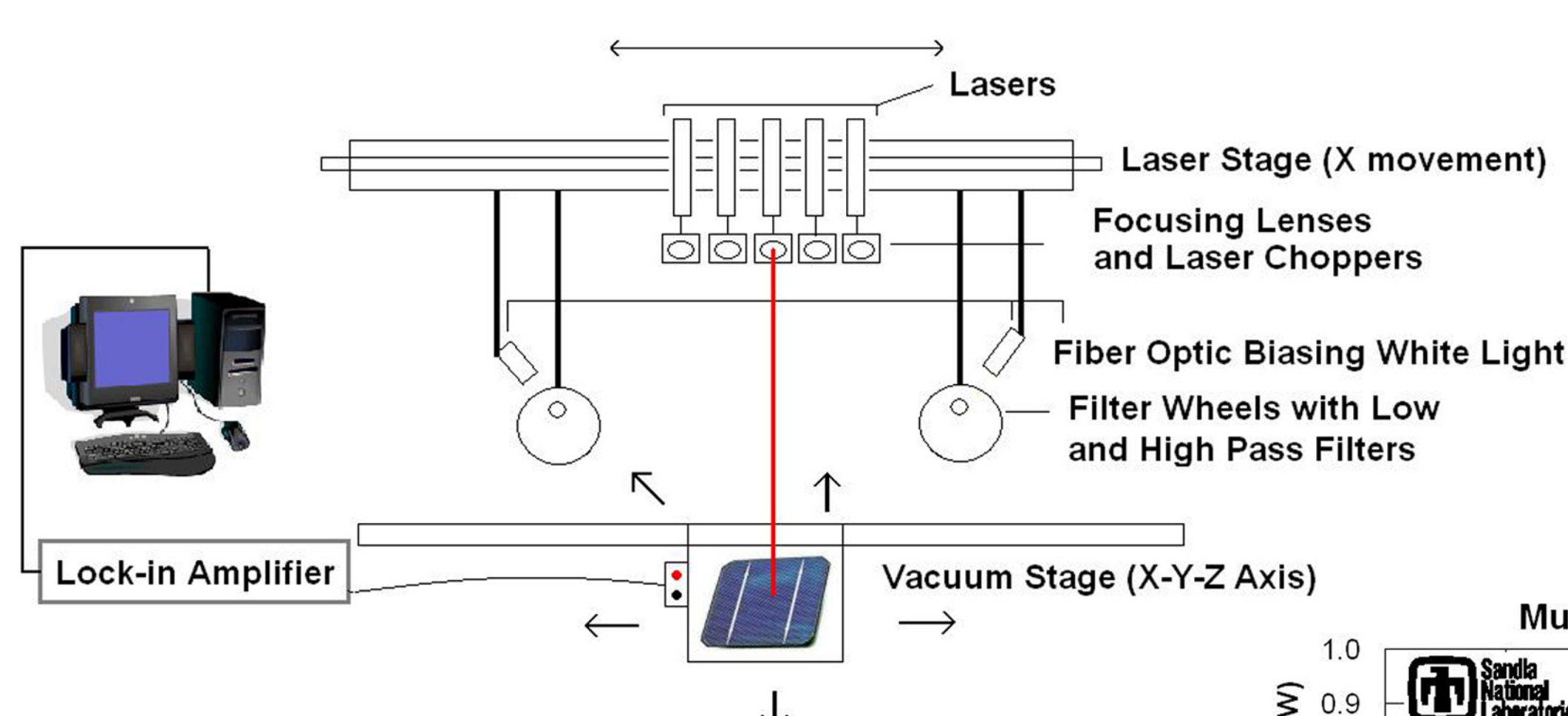
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Abstract

A Laser Beam Induced Current (LBIC) measurement is a non-destructive technique that produces a spatial graphical representation of current response in photovoltaic cells with respect to position when stimulated by a light beam. Generally, a laser beam is used for these measurements because the spot size can be made very small, on the order of microns, and very precise measurements can be made.

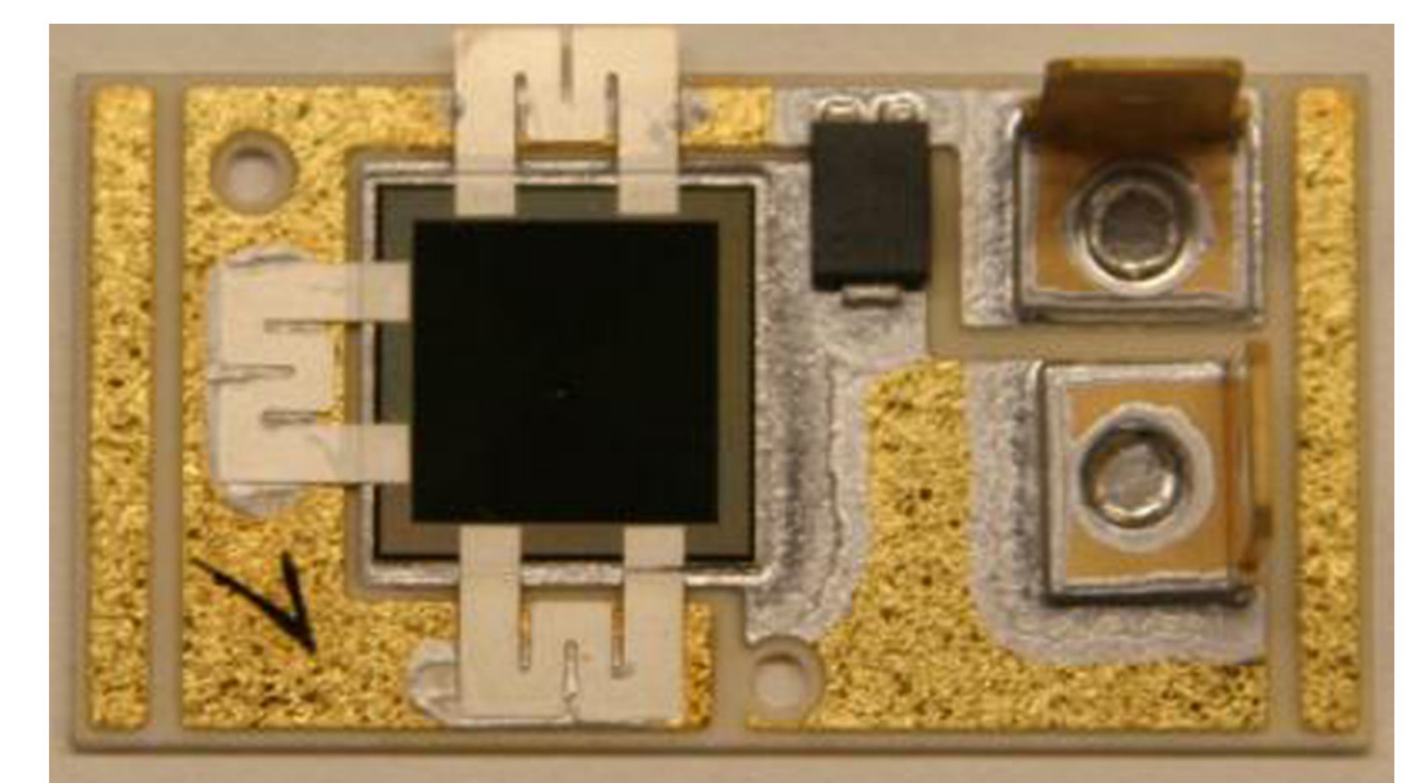
Sandia National Laboratories Photovoltaic System Evaluation Laboratory has optimized its LBIC measurement technique to characterize multi-junction solar cells currently being used in Concentrating Photovoltaic applications. There is a need to accurately characterize each junction within these cells. Sandia designed a technique to isolate and probe each junction in a series-connected multi-junction solar cell. The measurement technique and initial results are presented here.

Multiple Junction LBIC Setup



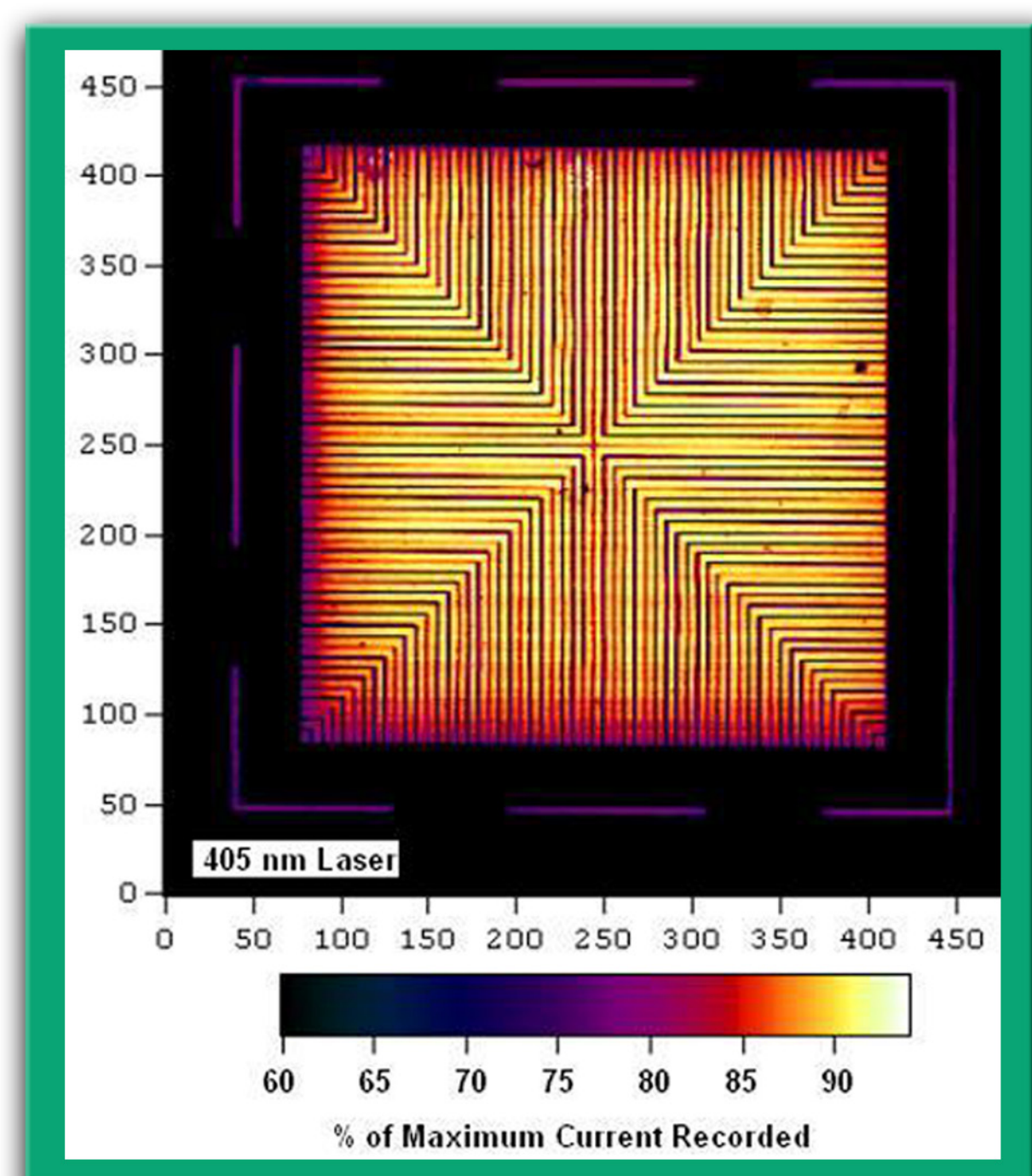
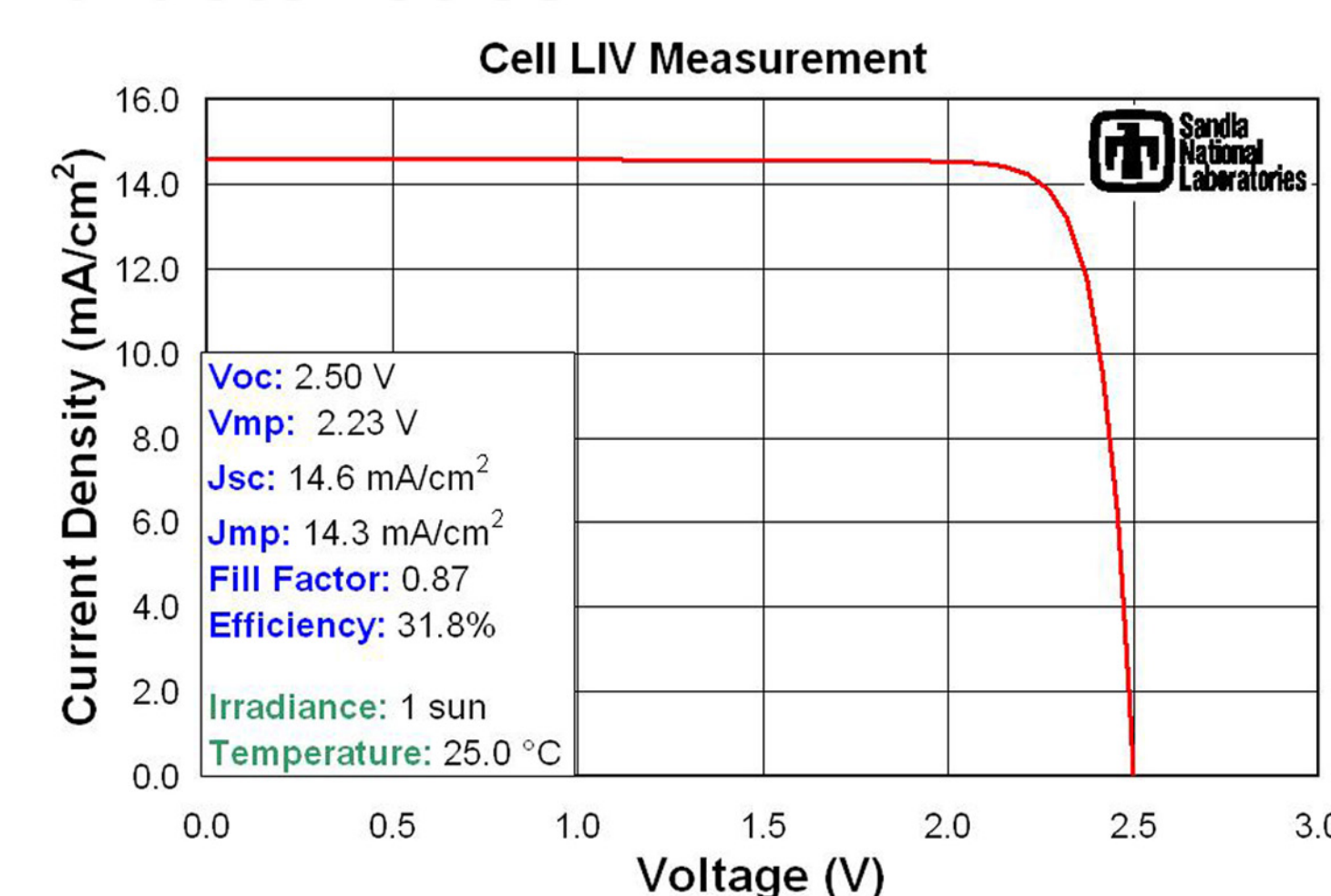
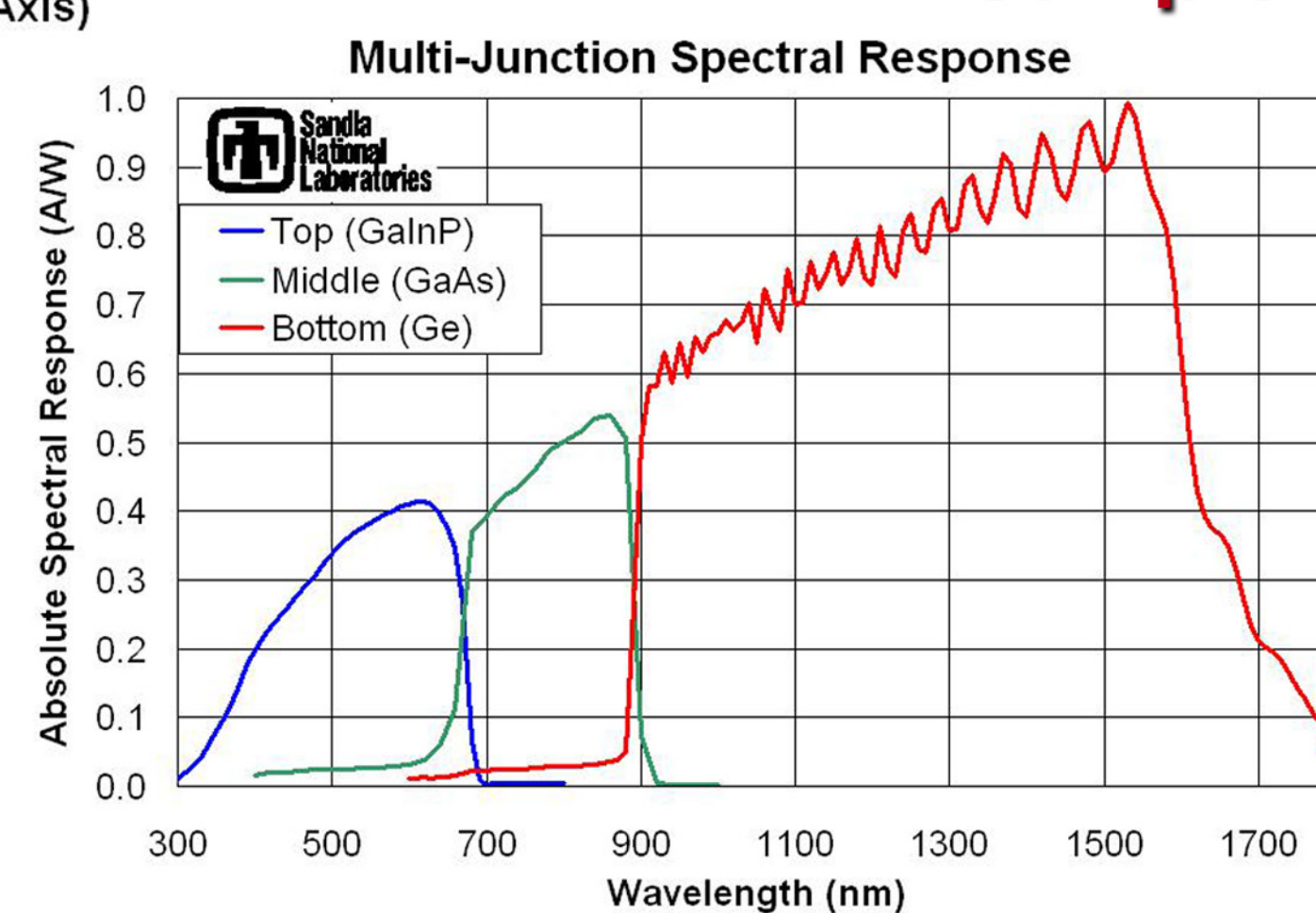
- X-Y-Z axis translation stage for cell sample
- Multiple lasers (405, 670, 830, 1064, 1310 nm) for characterization of multiple junction technologies
- 8 micron diameter laser spot size
- Two fiber optic 300W light sources with numerous long and short pass filters for greater versatility
- Fully automated testing capability
- Spectral response used to determine appropriate lasers and optical filters

Emcore Multi-Junction Sample Cell



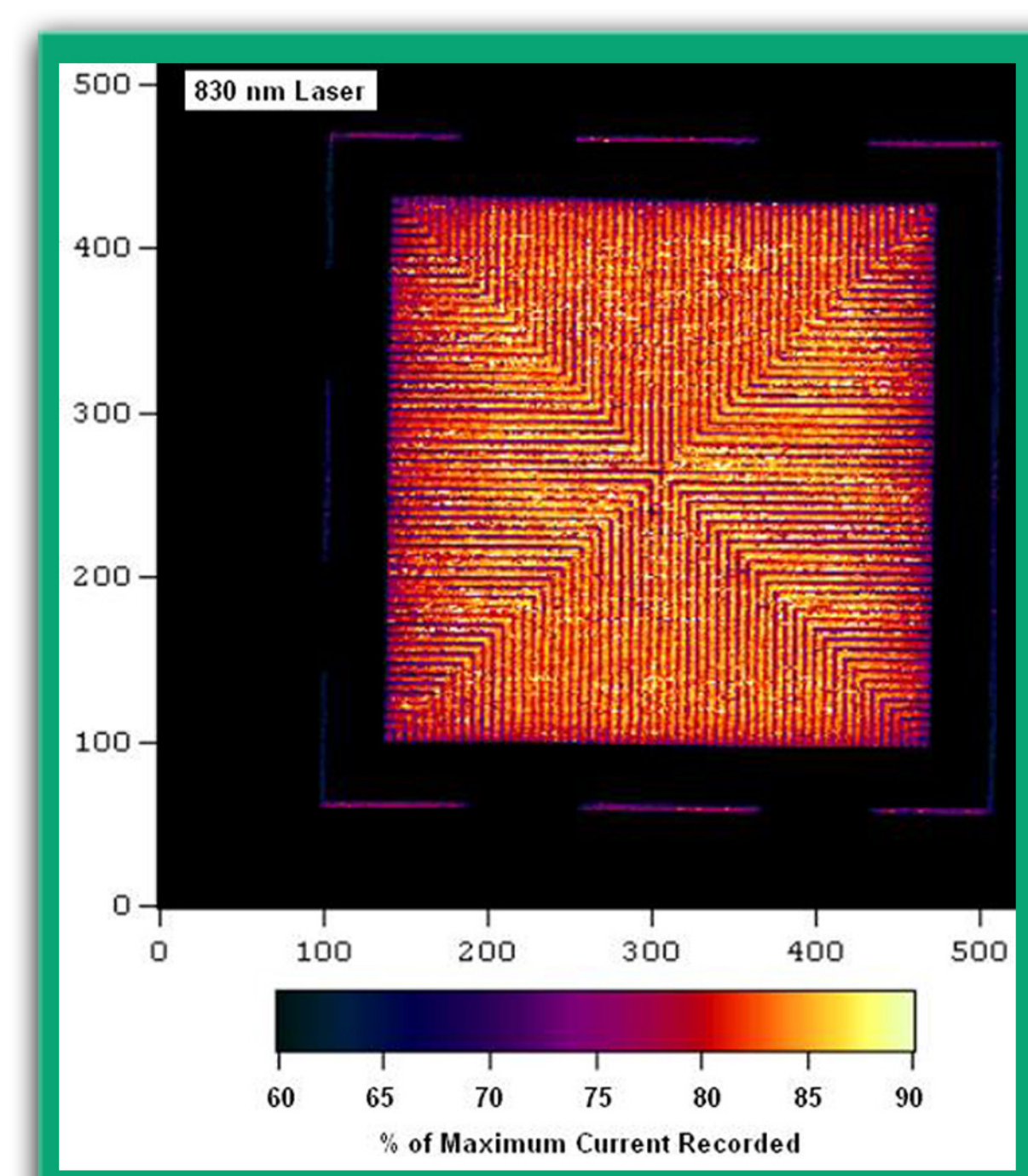
- Triple junction: GaInP/GaAs/Ge
- 1 cm² active area
- CPV cell assembly
- 2007 vintage lot

Sample Cell Characteristics



Top Cell: GaInP

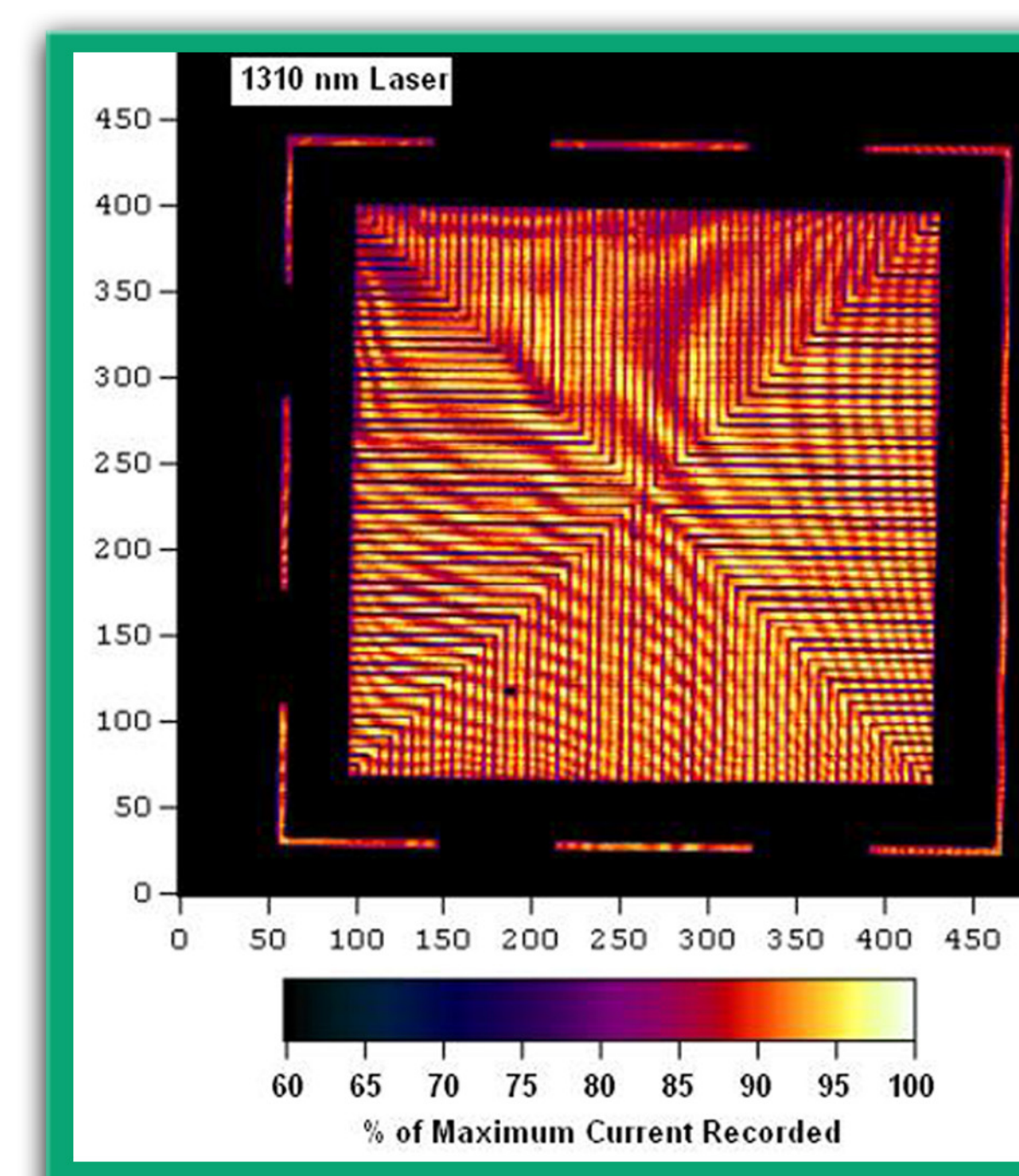
- 405 nm probe laser, 750 nm high pass bias filter
- Reduced current response along three cell edges
- Right edge of cell shows good response: no interconnect
- Could indicate interconnect solder process damaging the edges of cell



Middle Cell: GaAs

- 830 nm probe laser, 1100 nm high pass and 500 nm low pass bias filters
- Reduced current response along all four cell edges
- Grainy response may be due to current leakage from top and bottom junctions
- No significant defects detected

Initial Results



Bottom Cell: Ge

- 1310 nm probe laser, 800 nm low pass bias filter
- Edge effects less prominent
- Interference fringes notable and repeatable
- Moiré interference unlikely - Scan on the right taken at a different step interval (20 microns) and a 30 degree angle from original orientation (scan on left)
- Indicates the pattern is not an artifact due to gridline interference with laser
- Pattern most likely due to interference from much thinner top and middle cell layers

Conclusions

Sandia National Laboratories has successfully demonstrated the ability to accurately characterize each junction in a multi-junction solar cell using the LBIC technique. This technique allows multi-junction solar cell designers and manufacturers to perform in-depth diagnostics on each junction. This technique can diagnose non-uniform cell response, microcracking, metallization defects, and other material or growth-driven imperfections which reduce power output that are not easily identified using existing diagnostics.



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